WAR DEPARTMENT
CORPS OF ENGINEERS

Bulletin No. 20

Survey of Northern and Northwestern Lakes

BEARINGS ARE TRUE AND DISTANCES
ARE EXPRESSED IN STATUTE MILES

This Bulletin is a complete revision compiled from former Bulletins; from surveys made by the U. S Lake Survey (Lt. Col. C. S. Riché, Corps of Engineers, in charge); from annual and special reports of the officers of the Corps of Engineers, U. S. Army; from publications of the U. S. Bureau of Lighthouses; from information supplied by the Canadian Departments of Marine and Fisheries, Public Works, and Railways and Canals; and from revisionary data related to the river and harbor improvements carried on by the U. S. Engineers Offices on the Great Lakes, in charge of the following officers of the Corps of Engineers: Col. C. McD. Townsend, Detroit, Mich.; Col. John Millis, Cleveland, Ohio; Lt. Col. J. G. Warren, Buffalo, N. Y.; Lt. Col. Geo. A. Zinn, Chicago, Ill.; Lt. Col. C. S. Riché, Grand Rapids, Mich.; Major Francis R. Shunk, Duluth, Minn.; Major Chas. S. Bromwell, Milwaukee, Wis.; and Captain W. L. Guthrie, Oswego, N. Y. The matter has been edited and its publication supervised by Mr. O. C. Hattery, U. S. Lake Survey Office.

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only be necessary to maintain the depths sought by redredging as frequently as the local conditions may require.

Rules and Regulations Governing the Navigation and Use of the entrance channels and sheltered areas of the harbors of Conneaut, Ashtabula, Fairport, Cleveland, Lorain, and Huron, in the State of Ohio:

The Law.

See section 4 of the river and harbor act of August 18, 1894, as amended June 13, 1902, published in U. S. Laws on pages 11-15.

Rules and Regulations.

In conformity with the above law, the following rules and regulations were prescribed by the Secretary of War, June 10, 1903, and amended January 27, 1911.

1. The speed of all vessels moving in the channels or sheltered areas in the harbors of Conneaut, Ashtabula, Fairport, Cleveland, Lorain, and Huron, in the State of Ohio, shall be reduced to and shall not exceed a rate of six statute miles per hour.

2. While dredging, construction, or repairing operations are in progress in the channels or on the jetties or breakwaters, all vessels shall slow down to a speed of four miles per hour, or less, if required, while passing such dredges or places where work is being done, when requested to do so by the display of a red flag or lantern, or by the blowing of a succession of short blasts of the whistle.

3. No vessel shall moor or tie to the west jetty or tie to the east jetty, abreast of another vessel, in the harbor of Cleveland, Ohio, and no vessel shall moor or tie to the west inner Government pier in the harbor of Lorain, Ohio.

4. The mooring of vessels to the United States breakwaters shall be under the direction of the United States Engineer Officer in charge of the district, or his authorized agent, and vessels will not be permitted to moor where repair work is in progress or within 100 feet of where a red flag or lantern is displayed, and must move at once when directed to do so by the said Engineer Officer or his agent.

5. These regulations shall go into effect immediately.

DETAILED DESCRIPTIONS OF COAST LINE, HARBORS, ISLANDS, AND REEFS.

SECTION I.

SOUTH SHORE FROM BUFFALO, N. Y., TO ERIE, PA., INCLUDING NEW YORK STATE CANAL SYSTEM.

Charts: Lake Erie; Coast-chart No. 1; Coast-chart No. 2; Buffalo Harbor and Niagara River to the Falls; Dunkirk Harbor; Erie Harbor.

BUFFALO HARBOR, N. Y. Buffalo Creek or River was the original harbor for the port of Buffalo. In its primitive condition it was shallow and closed by a gravel bar the larger part of the year. It now has capacity under ordinary conditions for vessels drawing 20 feet. The works of improvement built by the United States are: The north and south piers at the entrance to Buffalo River and the City Ship Canal, which, with the Lehigh Valley Railroad basins and various slips, constitute the inner harbor of Buffalo; the sand-catch pier, and an outer breakwater which forms the outer harbor of Buffalo and protects the Buffalo lake front from Stony Point to the head of the Niagara River, a distance of about 4½ miles. Details are shown on the chart of Buffalo Harbor and Niagara River to the Falls.

Project. The projects for the improvement of this harbor are completed, except the final details of an extension to the Stony Point section of breakwater for the purpose of protecting the south harbor entrance; the removal of rock shoals outside of the north entrance; and the removal of the Watson elevator site to widen the Buffalo River entrance channel.

Breakwater. The outer breakwater lies about 3,000 feet out from the shore line, is generally parallel to it, and is built in four sections: First, the north breakwater, 2,203.5 feet long, protecting the lake front and entrance to Erie Basin and Black Rock Harbor north of the Buffalo River entrance. Second, the old breakwater, 7,608.6 feet long, between which and the north breakwater is the present north entrance to the inner and outer harbors of Buffalo, with an available width of 1,000 feet. Third, the south harbor section of the breakwater, beginning at a point abreast of the southerly

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end of the old breakwater, but 250 feet to lakeward, so as to leave a fair weather entrance 250 feet wide, and extending thence southerly 9,989 feet to the new south entrance, which has an available width of 550 feet, with 28 feet depth. And fourth, the Stony Point section of breakwater, 2,802.9 feet long, and extending from the south entrance to the shore of Stony Point, and having also an arm 1,000 feet long projecting lakeward as a protection to the south entrance. The sand-catch pier is 1,148 feet long, jutting out from the beach behind the outer breakwater about 1½ miles south of the piers.

The Outer Harbor, from the north entrance, Buffalo breakwater north end light, to the south entrance, Buffalo breakwater south side light, is 3½ miles long. There is an established United States harbor line 1,600 feet from and parallel to the breakwater, and coinciding generally with the 18-foot contour of water depth. The area of this outer harbor is about 680 acres; over 570 acres of this area the depth of water is 19 to 30 feet at mean lake level; and over the remainder, along the harbor line, the depth of water is 15 to 19 feet.

This is all good anchorage ground and mooring facilities are also provided along 7,714 feet of the breakwater (none along the stone portions—one 1,910 feet and one 9,883 feet long). There are 89 large mooring rings on 4,894 feet of the old breakwater adjoining the north harbor entrance, and 25 on 1,800 feet of the south harbor breakwater adjoining the south harbor entrance. See Underwriters' requirements for winter mooring, at the end of this description.

The outer harbor, in addition to providing a safe place of refuge and anchorage, is used as a channel way by lake vessels entering at the north entrance and bound for the Lackawanna Steel Company, the Buffalo and Susquehanna Iron Company, and the Pennsylvania Railroad Company ore docks at the south end of the harbor; also by vessels entering at the south entrance, bound for the Buffalo River or inner harbor. Such use by the largest and deepest draft vessels on the lakes is extensive, but under present conditions the depth of water is not adequate for safe unobstructed navigation and for the maneuvering of deep draft vessels going to or leaving anchorage or moorings. The adequate depth required is 20 feet at all stages of water level; and to secure this depth at low water which occurs annually after September, a depth of 23 feet at mean lake level is required.

At the northerly end of the outer harbor, adjoining the Buffalo River entrance channel, an area about 2,000 feet long and 1,600 feet wide, from the breakwater to the harbor line, is less than 23 feet deep at mean lake level, there being many shoal spots on which the depth is only 19 to 20 feet. Thence southerly to the south entrance, the depth is more than 23 feet at mean lake level for at least 800 feet of the harbor width of 1,600 feet, and the depth over the remaining 800 feet of harbor width, adjoining the harbor line, decreases gradually to from 15 to 19 feet along the harbor line. This limited width of the area of adequate depth at the south entrance involves difficulty and obstruction to navigation, for the reason that large vessels, 400 to 600 feet long and drawing 18 to 20 feet, cannot make the turn required at the south entrance without entering the shoal water and going aground.

Vessels navigating the outer harbor should keep at least 100 feet away from the "old section" of the breakwater, and vessels seeking moorings and tugs and small boats passing along the breakwater are warned to approach it with caution, to avoid striking on riprap close along the harbor face. The depths over this riprap, located by 100-foot stations numbered in white paint on the parapet, are as follows: Station 1 (at Buffalo breakwater north end light) to station 8, 10 to 15 feet; thence to station 11, 8½ to 11 feet; thence to station 16, 5½ to 10 feet; thence to station 49, 13 to 17 feet; thence to station 68 (stone structure—no mooring facilities), 3½ to 9 feet; thence to station 76 (south end), 19 to 21 feet.

Masters are also warned not to approach nearer than 100 feet to the harbor face

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of the stone breakwater with vessels or boats of even light draft, as there is danger of striking the stone riprap within this 100-foot limit.

Lights. The established lights are: **North Entrance.** Buffalo north breakwater south end, a fixed red light, visible 8½ miles, on southerly end of north breakwater, north side of this entrance. Buffalo breakwater north end, fixed red, visible 13 miles, on northerly end of old breakwater, south side of this entrance; a steam fog whistle, blasts 3 seconds, silent intervals 57 seconds, is located at this point. The main Buffalo light, flashing white every 5 seconds, visible 16½ miles, on the south pier about 342 feet back from its outer end. **South Entrance.** South Buffalo north side, fixed white, visible 13 miles, on southerly end of south harbor section of breakwater. South Buffalo south side, one red and two white flashes alternately, interval between flashes 10 seconds, visible 15 miles, on northerly end of Stony Point breakwater; a compressed-air fog siren sounds blasts of 2 seconds, with silent intervals of 28 seconds.

Life-Saving Station is located at the mouth of Buffalo River in rear of Buffalo light.

Storm Warnings. Day and night signals are displayed from a steel tower and a flagstaff on the Prudential building, corner of Pearl and Church streets; from a steel tower at the life-saving station; and from a steel tower on ore dock, east side of Lackawanna Steel Company's canal.

Entering Buffalo Harbor by North Entrance. The clear width of opening between the breakwaters is 1,300 feet. The approach to this entrance from Lake Erie outside of the breakwater is over irregular rock bottom. There was originally a shoal area of hardpan and bed rock about 1,200 feet long and about 700 feet wide, with its longer axis at right angles to the breakwater and its inner end about 400 feet due west of the north end of that structure. The original depth over this area was from 20.7 to 23 feet at mean lake level. The removal of the shoal, so far as funds allow, was begun in 1907, but has progressed slowly largely due to the sea preventing the operation of drill boats on drilling and blasting rock. At the close of the season of 1910, the southerly half of the shoal—300 feet of its width—had been excavated for its full length east and west, to 21.7 to 24 feet depth at mean lake level. During 1911, the cleaning up of this part of the channel will be completed and the channel widened to the northward as funds permit. Vessels can enter or clear on a course 38° (NE. ⅝ N.) passing 100 to 300 feet from the end of the breakwater, but long and deep-draft vessels should use the channel marked by gas buoys north of the shoal, or the south harbor entrance.

Another shoal, lying lakeward from the one above mentioned, and 1,900 feet due west from Buffalo breakwater north end light, is 350 feet long east and west and 150 feet wide north and south, and there is less than 20 feet of water over it, with a least depth of 18.8 feet at mean lake level. On September 3, 1909, three gas buoys were set in positions marking this shoal and the channel north thereof, and a red spar buoy was set approximately in the former position of red gas buoy No. 2. The channel marked by these buoys is not less than 400 feet wide and 21.7 feet deep at mean lake level.

Vessel masters are warned to take great care in the vicinity of drill boats and dredges working on the shoal and to pass them at a safe distance. The ruling depth for entering this entrance at the low stages produced by easterly winds, or during low water late in the fall, is 19 feet. If there is sufficient sea at low stages of water to cause vessels to pitch, great care should be used to avoid striking bottom; and if vessels are drawing more than 19 feet, the south harbor entrance should be used.

Vessels should not approach within 50 feet of the north end of the breakwater at the Buffalo breakwater north end light on south side of the entrance channel, as stone has been deposited there as riprap.

The channel from Buffalo breakwater north end light to the entrance channel between the piers at the mouth of Buffalo River is 3,100 feet long. The outer 700 feet of this channel is 400 feet wide and from 21½ to 23 feet deep at mean lake level. The next 2,400 feet, to the outer end of the north pier, was dredged during 1905 to a depth of 23 feet for a width of 300 feet at the outer end, diminishing to 200 feet 100 feet from

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the end of that pier, and to 150 feet at the end of the pier. The south side of this channel is parallel to and 100 feet north of a line connecting the north end of the old breakwater with the channel face of the south pier at its outer end. During 1911, this channel will be widened 100 feet along its south side, or to the line connecting the points above mentioned. The north breakwater and other works at times develop a strong northerly current across this channel; navigators should guard against this by holding up towards the south pier on entering, or towards the breakwater light on leaving port.

Wreck. The steel steam vessel W. C. Richardson, cargo flaxseed, sank during the night of December 8, 1909, in Lake Erie outside of Buffalo breakwater, 204° (SSW. ⅛ W.) 2 miles from Buffalo breakwater north end light, and 1⅝ miles out from the breakwater, at right angles thereto, at a point 5,600 feet southerly from said light. The wreck lies in 38 feet of water, bow towards the breakwater projecting 10 feet above water, forward spar and pilot house standing, stern and after deck and cabin submerged, and smokestack gone. The wreck is marked at night by a white light 25 feet above water and a red light 20 feet above water, both suspended from the foremast shrouds. Repeated attempts to raise the vessel have been unsuccessful.

Waverly Shoal has a least depth of 14.5 feet, at its north end, located 2⅛ miles SW. by W. ½ W. from the breakwater north end light. The northerly end of the shoal extends east and west about 1,000 feet, and a red and black bell and gas buoy, showing a white light 10 seconds, eclipsed 10 seconds, is moored near the shoalest spot. A depth of 16½ feet is found for a distance of about 600 feet southerly from the gas buoy, and there is a depth of 21½ feet at a point about 1,600 feet S. by W. ¾ W. from the buoy.

Entering Buffalo Harbor by South Entrance. The approach to this entrance is clear with a depth of more than 30 feet. The available width of the entrance is 550 feet between the south end of the south harbor section and the protection arm of Stony Point section of the breakwater; the depth is 28 feet at the mean lake level. The outer end of the protection arm is marked by a red gas buoy showing a white light 10 seconds, eclipsed 10 seconds. Vessels should pass to the north of this buoy in passing through the south entrance, and to the west of it in passing parallel to the breakwater.

Lackawanna Canal and Buffalo & Susquehanna-Pennsylvania Canal. The channel from the south entrance to the mouth of the Lackawanna Steel Company's canal is 1,900 feet long and 23 feet deep at mean lake level. Private red range lights on the steel company's dock, on easterly side of canal, mark the range of the channel. This canal is 23 feet deep and 3,000 feet long from the southerly end of the outer harbor into the Lackawanna steel plant property at Stony Point.

The channel from the south entrance to the Buffalo & Susquehanna-Pennsylvania canal is 2,000 feet long and 23 feet deep at mean lake level. This channel diverges from the channel to the Lackawanna Steel Company's canal in the deep water 800 feet from the entrance, and extends straight in to the mouth of the canal for the remaining 1,200 feet. All of the area between these two channels is 23 feet deep at mean lake level. The canal is 23 feet deep, 200 feet wide, and about 4,000 feet long, and extends into the properties of the Pennsylvania and the Buffalo & Susquehanna Railroad Companies, about 600 feet north of the south city line.

Bridge. The Hamburg turnpike highway bridge across the Buffalo & Susquehanna-Pennsylvania canal has a single leaf lift operated by electricity, 6½ feet high above water surface, 80 feet clear width of opening. On opening engineer blows one blast of whistle, and on closing two blasts. One red light on center of bridge shows in either direction. Red lights show on each abutment.

Channel between piers. The entrance channel between the piers at the mouth of Buffalo River is 1,240 feet long from the outer end of the north pier to the junction of the City Ship Canal and Buffalo River, and is maintained by the United States. This

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channel is from 23 to 25 feet deep for a width of 150 feet, from the outer end of the north pier to within 400 feet of the junction of Buffalo River and the City Ship Canal; this easterly 400 feet is from 21¼ to 23 feet deep, with rock bottom. Widening of this channel at its inner end by removing the ruins of the Watson elevator and dredging its site to a depth of 23 feet will be begun in 1911. The north pier is 775 feet long, all inside shore line, and the south pier 1,760 feet long, extending lakeward 985 feet farther than the north pier and 1,330 feet beyond the shore line.

Fluctuations of Lake Erie at Buffalo. Water level of Lake Erie at Buffalo, compiled from record of automatic gage located in U. S. lighthouse slip, south pier, covering the years 1897 to 1910, inclusive. These figures are referred to the mean level of Lake Erie as indicated by the zero of the Buffalo gage, 572.8 feet above mean tide at New York.

Yearly Means.	The Highest Stage.	The Lowest Stage.
1897 minus 0.70 foot.	Nov. 6, plus 2.5 feet.	Nov. 9, minus 3.9 feet.
1898 minus 0.52 foot.	Nov. 6, plus 4.3 feet.	Dec. 4, minus 4.1 feet.
1899 minus 0.78 foot.	Dec. 12, plus 4.5 feet.	Dec. 14, minus 2.6 feet.
1900 minus 0.81 foot.	Nov. 21, plus 6.7 feet.	Nov. 25, minus 3.5 feet.
1901 minus 1.38 feet.	Oct. 13, plus 2.8 feet.	Mar. 13, minus 4.1 feet.
1902 minus 0.83 foot.	Nov. 30, plus 3.5 feet.	Dec. 13, minus 5.0 feet.
1903 minus 0.38 foot.	Feb. 8, plus 4.4 feet.	July 18, minus 3.2 feet.
1904 minus 0.24 foot.	Dec. 28, plus 4.7 feet.	Jan. 2, minus 3.3 feet.
1905 minus 0.50 foot.	Oct. 20, plus 4.5 feet.	Feb. 5, minus 2.6 feet.
1906 minus 0.38 foot.	Oct. 27, plus 5.7 feet.	Mar. 19, minus 2.7 feet.
1907 0.0 foot.	Jan. 20, plus 6.6 feet.	Dec. 14, minus 2.8 feet.
1908 plus 0.01 foot.	Feb. 1, plus 4.7 feet.	Dec. 17, minus 3.1 feet.
1909 minus 0.61 foot.	Dec. 7, plus 5.6 feet.	Feb. 14, minus 4.2 feet.
1910 minus 0.90 foot.	Oct. 27, plus 3.1 feet.	Jan. 14, minus 3.4 feet.

It frequently happens that the highest and lowest stages of water recorded during any month occur on the same day, as was the case on March 13, 1898, November 3, 1899, September 12 and December 9, 1900, and October 13, 1901. The highest and lowest of a year may be but a few days apart, as on December 12-14, 1899, November 21-25, 1900, and November 30-December 13, 1902.

As will be seen by the above table, the highest water reached during the 14 years was November 21, 1900, the stage being plus 6.7 feet, and the lowest on December 13, 1902, when minus 5.0 feet was recorded; the extreme range of fluctuation being 11.7 feet.

Monthly Means. The following table gives the monthly mean stages of the lake at Buffalo for the last 14 years. Figures show the feet and decimals below or above mean lake level.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1897.....	−1.12	−1.55	−1.04	−0.52	−0.10	−0.11	−0.13	−0.25	−0.61	−1.05	−1.01	−0.89
1898.....	−1.02	−1.13	−0.75	−0.15	−0.02	+0.02	−0.20	−0.24	−0.62	−0.79	−0.69	−0.63
1899.....	−0.75	−1.21	−0.86	−0.80	−0.65	−0.35	−0.31	−0.70	−0.77	−0.90	−1.15	−0.82
1900.....	−1.20	−1.20	−1.25	−0.67	−0.41	−0.35	−0.50	−0.35	−0.73	−1.06	−0.98	−0.95
1901.....	−1.18	−1.77	−1.99	−1.70	−1.63	−1.13	−0.90	−1.15	−1.06	−1.24	−1.45	−1.40
1902.....	−1.26	−1.65	−1.67	−1.15	−0.93	−0.64	−0.14	−0.27	−0.55	−0.47	−0.69	−0.49
1903.....	−0.69	−1.02	−0.66	+0.02	+0.03	+0.09	+0.20	−0.21	−0.27	−0.52	−0.75	−0.77
1904.....	−1.45	−1.35	−0.60	+0.29	+0.32	+0.18	+0.27	+0.21	+0.04	+0.04	−0.55	−0.73
1905.....	−1.00	−1.52	−1.68	−1.01	−0.46	+0.09	+0.28	+0.05	−0.01	−0.20	−0.32	−0.20
1906.....	−0.28	−0.73	−1.04	−0.68	−0.34	−0.11	−0.03	−0.11	−0.43	−0.39	−0.33	−0.15
1907.....	+0.38	−0.23	−0.52	−0.06	+0.03	+0.31	+0.46	+0.15	+0.01	−0.13	−0.20	−0.23
1908.....	+0.18	−0.34	−0.07	+0.48	+0.72	+0.69	+0.55	+0.34	−0.13	−0.72	−0.67	−0.89
1909.....	−1.35	−1.15	−1.01	−0.80	−0.05	+0.15	+0.13	−0.14	−0.45	−0.75	−1.17	−0.77
1910.....	−1.47	−1.76	−1.18	−0.88	−0.32	−0.35	−0.43	−0.63	−0.90	−0.82	−0.96	−1.12
Average 14 years..	−0.87	−1.19	−1.02	−0.54	−0.27	−0.10	−0.05	−0.23	−0.46	−0.64	−0.78	−0.72

The month having the highest average stage is July, and the lowest, February.

The table shows that at Buffalo the periods of lowest water during the navigation season are in the spring and fall, the busiest portions of the year in the harbor, and when the necessity for deep water is greatest.

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The Inner Harbor at Buffalo may be divided into four sections, viz.: Buffalo River, the City Ship Canal and Lehigh Valley Basins, Erie Basin, and Black Rock Harbor.

Buffalo River. This section embraces Buffalo River from its mouth at the head of the entrance channel between the U. S. Piers and junction with the City Ship Canal, to the L. S. & M. S. Railway bridge, 3½ miles upstream. All of the Buffalo River section of the inner harbor is maintained by and under the jurisdiction of the city of Buffalo. The river course is fairly straight for 1⅜ miles from the mouth. At this point there is a bend of about 90 degrees to the eastward on an easy curve in which the Ohio street lift bridge is located. At 1⅞ miles from the mouth occurs another bend, to the southward, of more than 90 degrees on a quite sharp curve. Just around this bend, 2¼ miles from the mouth, are located the Buffalo Union Furnaces and docks, which are now at the head of this section of the inner harbor navigable for lake vessels. From the furnace docks the river course is very sinuous with sharp bends for 1¼ miles to the L. S. & M. S. Railway bridge, which is a fixed bridge practically blocking the development of navigation farther upstream. No dock exists above the Union Furnaces and docks. The width of the channel between the practically continuous lines of docks from the mouth of the river to the furnace docks is 175 to 300 feet, averaging 200 feet, and the depth is generally 22 to 23 feet at mean level of Lake Erie.

Above the site of the burned Watson elevator the river bottom is soft clay and mud overlying rock to a depth ranging from one to several feet, upstream as far as Ohio street bridge. Vessels grounding in this portion of the river seldom suffer damage due to contact with the bottom. Above the Ohio street bridge the channel is cut through solid rock, and care must be used to avoid striking rock on the south edge of the channel.

The currents in the river are slight and offer no difficulties to navigation under normal conditions. Rapid fluctuations in Lake Erie produce quite strong currents in the river within one mile of the mouth, inflowing or outflowing as the case may be, and heavy rainfalls and spring freshets are attended by strong outflowing currents due to rapid rises of the river and the consequent discharge of flood water. These conditions cause difficulties to navigation and sometimes damage to vessels by tearing them from their moorings, but occur only two or three times each year and for only a few hours at a time. Heavy ice forms in the river, usually in December. A narrow channel is kept open through the ice by fire tugs, but the ice remains in place because Lake Erie also freezes over, and the harbor entrance is usually blocked with solid ice from December to March or April. The ice usually goes out in the spring during a freshet in the river, and the combined effect of the then prevailing strong outflowing currents and the heavy moving ice is at times very great and may last for two or three days. During this time the liability of damage to vessels is considerable.

The work of improving Buffalo River upstream from "south line of lot 65, Indian Reservation," which is opposite the Buffalo Union Furnaces, has been a matter of controversy between different city interests for many years. It was first advocated in order, primarily, to abate floods which inundate, principally during spring frshets, a large low-lying section of the city adjacent to the river, and, secondarily, to secure deep water navigation to large manufacturing plants, existing and proposed.

There is little or no fall in the river at ordinary stages, it being practically at lake level to the east city line, except during the discharge of flood waters. At the present time, it is understood that the navigation feature of the improvement is considered as primary.

In 1906, the improvement was authorized by the State Legislature and adopted by the Common Council of the City of Buffalo, "as a general plan for the work of widening, straightening, enlarging, clearing from obstructions, dredging, deepening, and embanking and diking Buffalo River and Cazenovia Creek, and for altering of the courses of said river and creek, and for the construction of new channels for the same,

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and for putting in navigable condition said Buffalo River within the limits of said city." The proposed improvement embraces:

Buffalo River from south line of lot 65, Indian Reservation, to its junction with Cazenovia Creek.

Buffalo River from its junction with Cazenovia Creek to the easterly city line.

Cazenovia Creek from its junction with Buffalo River to Cazenovia street.

Actual work was begun in July, 1909, for the construction of that portion included between the south line of lot 65, Indian Reservation, and the northeasterly line of Abbott road, a length of 14,400 feet. The work is in progress below the Lake Shore bridge.

Ohio Basin is an artificial waterway about 1,100 feet long and 500 feet wide, connected on the south with Buffalo River about 1⅛ miles above its mouth by the Ohio Basin Slip, which also extends northerly from the basin to the south line of Elk street. The basin is from 8 to 13 feet deep and is used almost exclusively by lumber vessels. The part of the slip connecting the basin with Buffalo River is about 500 feet long, 56 feet wide, and 13 feet deep. The part of the slip from the basin north to Elk street is about 780 feet long, 70 feet wide, and 12 feet deep. Ohio Basin and Ohio Basin Slip are under the jurisdiction of the state of New York, being a part of the Erie Canal system.

Peck Slip, or Main Street Slip, is a channel about 400 feet long, 250 feet wide, and 19 feet deep, connecting Buffalo River with the City Ship Canal opposite the foot of Main street, about ½ mile above the mouth of the river. After passing above the junction of the river and ship canal this slip is the only navigable connection between them; it is used by the largest lake vessels, with aid of tugs to make the sharp turns at each end.

Evans Slip is a channel on the north side of the Buffalo River at its mouth, extending to elevators and lumber docks; it is about 700 feet long, 60 to 80 feet wide, and 19 feet deep, and is crossed by D., L. & W. R. R. swing bridge.

Commercial Slip is a channel connecting Buffalo River and the Erie Canal at the terminus of the canal. It is about 600 feet long, 60 feet wide, and 6½ feet deep, and is crossed by three fixed bridges, with a clear height under them of 13 feet; it is used only by canal boats and small tugs.

Shipyards and dry docks are on the south side of Buffalo River, one mile from the mouth.

Bridges, Buffalo River and Slips. There are two bridges across this section of the Buffalo River, viz.: Michigan street bridge, ¾ mile above the mouth, and Ohio street bridge, 1½ miles up. There are also three bridges across the Ohio Basin Slip and one across Evans Slip.

No.	Location and name	Kind	Height above mean lake level	Draw opening in the clear	Remarks
				Center	
			Feet	Feet	
1	Michigan street	Highway—two-leaf lift	15	132	See Note 1.
2	Ohio street	Highway—one-leaf lift	12	138	See Note 2.
3	Ohio Basin Slip, Erie Ry.	Railway—swing	7½	44	See Note 3.
4	Ohio Basin Slip, N. Y. State Canals	Highway—swing	7½	44	See Note 4.
5	Evans Slip, Delaware, Lackawanna & Western Ry.	Railway & highway—swing	8	56	See Note 5.
6	Ohio Basin Slip, D., L. & W. Ry.	Railway—swing	12	50	See Note 6.

Note 1. Operated by steam. On opening, engineer on north leaf blows one blast of whistle, answered by one blast on south leaf. On closing, one long and one short blast on north leaf, answered on south leaf.

One red light on upstream and downstream end of each abutment. One red light on upstream and downstream side on outer end of each leaf, swinging with leaf and showing green when bridge is open.

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Note 2. Operated by steam. On opening, engineer blows one blast of whistle; on closing, two blasts.

One red light on upstream and downstream end of rolling pier and lift pier. One red light on upstream and downstream side of lifting end, swinging with lift and showing green when bridge is open.

Note 3. Operated by hand. No lights.

Note 4. About 50 feet beyond Erie R. R. bridge. Operated by hand. No lights.

Note 5. Operated by hand or steam. No lights.

Note 6. Swing pier on east side of slip. Operated by steam. No lights.

City Ship Canal and Lehigh Valley Basins. An artificial waterway beginning at the mouth of Buffalo River and the head of the entrance channel between the United States piers, and extending thence southeasterly in the general direction of Buffalo River and 200 to 1,000 feet therefrom. The ship canal is nearly straight and about 2½ miles long to the turn at the Lehigh Valley Basins. The northerly 1½ miles is a public waterway constructed and maintained by and under the jurisdiction of the city of Buffalo. The remainder, about 1 mile to southerly end, was constructed and is maintained by the Lehigh Valley and allied railroad interests, but is open to the public under the same laws and regulations as other waterways.

The width of the ship canal is generally 200 feet and its depth 20 feet at mean lake level. The northerly end, from the junction with the Buffalo River at the site of the Watson elevator, thence southerly 900 feet, was deepened to 23 feet at mean lake level under a city contract which was completed in 1903. There is no current in the canal except from Peck Slip to the junction with Buffalo River and the entrance channel, during freshets in Buffalo River.

The Lehigh Valley basins are at the southerly extremity of the ship canal, communicating therewith by a connecting channel about 1,400 feet long and 200 feet wide, extending easterly at right angles to the canal. At the end of the connecting channel are two basins, north and south, at right angles to the connecting channel and 2,000 feet and 1,600 feet long, respectively, and 200 feet wide. The depth of water is generally 19 feet in the connecting channel and basins at mean lake level. A basin 1,600 feet long and about 100 feet wide lies intermediate between the north basin and ship canal, but it is not now in use.

Heavy ice forms in the ship canal and basins in winter, usually in December. A narrow channel is kept open through the ice by fire boats, but the ice remains in place the same as in Buffalo River. The ice drifts out on the opening of the entrance channel in March or April, or melts in place, and its breaking up in the spring is not attended with the same liability to damage as in the case of Buffalo River.

Bridges across City Ship Canal. There are three bridges across the City Ship Canal, as follows:

No.	Location and name	Kind	Height above mean lake level	Draw opening in the clear			Remarks
				*Right	Center	*Left	
			Feet	Feet	Feet	Feet	
1	South Michigan street	Highway—one-leaf lift	12½	.....	85	.....	See Note 1.
2	Buffalo Creek Ry.	Railway—swing	14	46½	.....	46½	See Note 2.
3	Hamburg turnpike	Highway—swing	14	46½	.....	46½	See Note 3.

*Looking north.

Note 1. One long whistle to open bridge; two to close.

One red light on upstream and downstream end of each abutment. One red light on upstream and downstream side of lifting end, swinging with lift and showing green when bridge is open.

Note 2. On part of ship canal owned by Lehigh Valley R. R. and operated by them as private bridge. Swung by hand. No lights.

Note 3. On same center pier as Buffalo Creek bridge and operated therewith. Swung by hand. No lights.

Lake Erie Entrance to Erie Basin and Black Rock Harbor. The channel from the

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outer harbor (at the north breakwater south end light) to the north entrance of Erie Basin and the Reading coal trestle is 22 to 23 feet deep at mean lake level and 400 feet wide. The branch channel or basin thence northwesterly to the entrance to Black Rock Harbor, foot of Maryland street, is 1,920 feet long, 500 feet wide, and 23 feet deep at mean lake level.

Erie Basin. This basin is formed by the New York State breakwater, a stone structure 2,240 feet long extending northerly in a straight line from the entrance channel between the United States piers, and inclosing, between itself and the docks on the original curved shore line of the lake, an area about 3,000 feet long and from 300 feet wide at the ends to 1,000 feet wide at the widest part at the foot of Genesee street. The Erie basin was originally constructed as a receiving basin for the Erie Canal (subsequently described). While still used as such, the development of lake commerce has made the deepening of the basin to accommodate lake vessels imperative, and improvements to this end are being made by the State of New York, under whose jurisdiction the basin was originally constructed and is now maintained. Heavy ice forms in the basin in winter and drifts out in spring when the outer harbor ice breaks up.

The navigable waters of the basin may be described as a strip 300 to 400 feet wide, following the line of the docks on the main shore and defined by the United States harbor lines, as shown on the charts. The channel for lake vessels follows within 100 feet of the line of the docks on the main shore, but at the present state of improvement is of irregular depth and width. Entering the basin at the south end from the Buffalo River entrance, the channel is 23 feet deep at mean lake level for a width of 100 to 150 feet, as far as the Exchange elevator; immediately in front of this elevator the channel is only 50 feet wide. From the Exchange elevator (or slip No. 1) to slip No. 2 the channel is 23 feet deep and 50 feet wide. From slip No. 2 to the north end of the basin the channel is 19 feet deep and 60 feet wide. Off the Reading coal trestle at the north end of the basin there is a deep pool from 18 to 20 feet deep and 300 feet wide. Vessels bound for the coal trestle and the lumber docks south thereof enter the basin at the north end, via the Lake Erie entrance above described. The depths over the remaining area of the strip between the harbor lines west of the channel range from 12 to 16 feet, gradually shoaling towards the west harbor line to from 3 to 10 feet. The shoalest water is at the south end of the basin. The area between the breakwater and the west harbor line may be described as flats covered by water 3 to 10 feet deep, soft sand and mud bottom.

There are three slips, No. 1, No. 2, and No. 3, connecting the Erie Basin with the Erie Canal. These slips are 60 feet wide, 8 to 10 feet deep, and are used only by canal boats and small tugs. There are several fixed bridges across each slip with height in the clear of 13 feet. Three old docks about 500 feet long and 80 feet wide extend into the basin from the State breakwater. They inclose two slips each about 200 feet wide and 8 feet deep in the center, 5 feet deep at docks. These docks are abandoned, except one occupied by a repair shipyard with two floating drydocks. There is another shipyard on the main shore.

Black Rock Harbor. This harbor might more properly be called a canal. It is a waterway 3⅛ miles long and 100 to 400 feet wide, lying along the Niagara River front of Buffalo generally parallel with the Niagara River and separated therefrom by Bird Island pier and Squaw Island, which serve as a dam or embankment to keep the water level of Black Rock Harbor and the Erie Canal at the level of Lake Erie. The Erie Canal lies between Black Rock Harbor and the main shore, and was formerly separated from the harbor by an embankment or pier. This waterway is being changed to a ship channel with a lock for lake vessels of the largest size, and in connection therewith the pier has been removed from opposite Fort Porter to Ferry street bridge, so that the harbor and canal form one body of water. At the north end there are openings in this embankment, and there also the harbor and canal form one body of water. A ship

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channel for passing vessels, and the latter are required to do the same when passing the dredges or other craft.

4. Hereafter no vessel of any kind shall anchor in the entrance channel to said Buffalo Harbor between the north and south United States piers, or be moored to or lie at the United States south pier, or be moored to or lie at the United States north pier abreast of another vessel at said United States north pier, under penalty prescribed by section 11 of the act of June 13, 1902.

This regulation shall not apply to Government vessels, or vessels of any character engaged in the work of improving the harbor or entrance channel.

5. These regulations shall go into effect immediately.

City Ordinances affecting navigation of the harbor:

It shall be the duty of the harbor master to keep an office in such place as the council shall designate, where at all times during the season of navigation he can be found, or where orders can be left and receive prompt attention.

The harbor master shall give such orders and directions relative to the location, change of place or station, manner of moving or use of the harbor, of every vessel, craft, or float lying, moving, or laid up in the harbor not in use, as may be necessary to promote good order therein and the safety and equal convenience of such vessels, craft, or floats; and any owner, master, or other person having charge of the same who shall refuse or neglect to obey any such order or direction shall be subject to the penalty of $25 for every such neglect or refusal.

No master, owner, or any person in charge of any vessel, craft, or float shall cause or suffer the same to remain at or within 100 feet of the south pier for a longer period than is actually necessary to furl sail on coming in or make sail on departing, under a penalty of $10: Provided, that rafts or vessels necessarily used in the construction or repair of the piers shall not be deemed to be within this provision.

No vessel, craft, or float shall be so moored or anchored within the harbor or in any slip or dock as to prevent the passage of any other vessel, craft, or float; nor shall any vessel, craft, or float be so moved as to run against or injure any bridge across the river or any branch thereof, under the penalty of not less than $10 nor exceeding $100 to the master, owner, or person in charge thereof, for each offense.

All vessels, craft, or floats navigating the harbor, when passing any bridge or ferry, shall be moved past the same as expeditiously as is consistent with a proper movement in the harbor, but in no case shall any craft or float while passing any bridge or ferry, and obstructing the passage across such bridge or ferry, move at a rate of speed less than two miles an hour; and no vessel, craft, or float shall be so anchored or fastened as to prevent any bridge from a free and speedy opening, or any ferry boat from a free and direct passage; nor shall any line or fastening be so thrown, laid, or made fast as to cross the track of any bridge or ferry, under the penalty of $25 for each offense specified in this section to the master or other person having charge of such vessel, craft, or float.

All vessels, craft, or floats not propelled by steam, navigating the harbor, for which the opening of any bridge may be necessary, shall while approaching and passing such bridge be towed by a steam tug, under a penalty upon the master, owner, or person in charge thereof of not less than $25 nor exceeding $100.

Whenever any person having charge of any vessel, craft, or float shall wish to move the same past any bridge, reasonable time shall be allowed for the opening of the same, and any person who shall move any vessel, craft, or float against any bridge or the draw of any bridge before the same shall be opened, to the injury thereof, shall be subject to a fine not exceeding $200, and be likewise answerable to the city for damages equal to the cost of repairing such injury.

No person discharging the cargo of any vessel, craft, or float shall suffer any part of such cargo to remain projecting over the front of any wharf after such vessel, craft, or float shall remove from the wharf, under a penalty to the master, owner, or other persons having charge of such vessel, craft, or float occupying such wharf, of $10 for every hour such projection shall continue.

All vessels using steam shall have their smokepipes so constructed as to prevent sparks or coals of fire escaping therefrom, and shall be moved slowly at a speed not exceeding three miles per hour and under a low head of steam. All tug boats or steam vessels used chiefly for towing shall have a joint in their smokepipes, and shall be constructed in all respects in such a manner as to be able to pass under any bridge which is not less than thirteen (13) feet above the surface of the water.

All sail vessels shall likewise be moved slowly and under short sail, so as not in any case to endanger or injure other vessels.

No master or other person owning or having charge of any vessel, craft, or float shall leave the same in the harbor without having on board or in charge thereof some competent

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person to control, manage, and secure the same, without first obtaining the permission of the harbor master.

No vessel laden in whole or in part with gunpowder or guncotton shall land at or make fast to any dock or wharf upon the Buffalo River or any waters connected therewith, or discharge such gunpowder or guncotton within said limits except by written permission from the harbor master, stating place and time for delivery or transfer. The harbor master shall prevent any vessel with gunpowder or guncotton on board from making fast to any wharf or dock, or unloading within the limits aforesaid.

All vessels, craft, or floats, whether using steam or otherwise, while in the harbor shall have and keep their anchors on board or suspended from the hawse pipe by the ring or shackle, and said ring and shackle shall be below the surface of the water, and their lower yards cockbilled and their upper yards braced up sharp.

They shall likewise have and keep out on board during the nighttime a conspicuous light and shall have extinguished or safely secured at dark all fires which may be kept on board.

No vessel, craft, or float shall be suffered to lie in the harbor adrift or insecurely fastened.

Any master, owner, or other person having charge of any such vessel, craft, or float shall be subject to a fine of not less than $20 nor exceeding $100 for every violation of any provision of this section, and to a like fine for every refusal to conform thereto when directed by the harbor master.

No person shall cast or deposit, or suffer to be cast or deposited, in the harbor or slips within the limits of the city, any earth, ashes, or heavy substance or substances, filth, logs, or floating matter, or any obstructions, under a fine of not more than $100 for each and every offense, and not more than $25 for every day the same shall be suffered to remain there.

The words "vessels," "craft," and "floats" shall be deemed to include every species of steam and other vessels or boats lying or floating in or navigating the harbor, and also all rafts of logs, timber, wood, lumber, or floating matter; and the harbor shall be deemed to include the Buffalo River to its junction with Cazenovia Creek and the waters connected with said Buffalo River, the piers, and so much of Lake Erie and Niagara River as lies within the limits of the city.

If any owner or master or other person in charge or command of or sailing any tug boat or towing boat in or upon the Buffalo River or any of the waters connected therewith, or upon Lake Erie within said city limits, shall run, sail, or cause to be run or sailed such tug boat or towing boat, or anything that they may have in tow, upon, against, or over any rope, chain or other fastening, mooring, any dredge or other machine used by said city for deepening, widening, and improving said lake and said river and the waters connected therewith, so that the said dredge or other machine shall be displaced, hindered, or delayed in the working thereof, such persons so offending shall forfeit and pay to the city any sum not less than $10 nor more than $100 for each offense.

The harbor master may at any time order the owner or captain of any tug in the Buffalo harbor to move, by means of such tug, to any place in said harbor any boat, vessel, or other craft or float; and the boat, vessel, or craft or float receiving such assistance shall pay the person or persons, owners, or captains rendering assistance.

No captain or person in charge of a tug in the Buffalo harbor shall permit any whistle upon such tug to be blown except for the purpose of giving and answering necessary signals; and no "four whistles" shall be answered while lying at the dock. Any violation of this section shall be punished by fine not to exceed $25.

Underwriters' requirements for winter mooring in connection with the Buffalo winter-mooring clause in marine insurance policies, which reads as follows:

"Warranted no claim owing vessel moored Outer Harbor Buffalo, after close of navigation, unless moorings specially approved by the Underwriters and additional premium paid if required."

The Underwriters have agreed to allow moorings under the Buffalo breakwater for the winter without additional premium except a small fee for supervision by their representative, provided vessels are moored under the following conditions:

Each vessel shall be moored separately, so that generally there will be 100 feet clear on each side of each vessel, head to the breakwater and not nearer than 75 feet, nor more than 100 feet from the breakwater, with two anchor chains forward, each 30 fathoms in length, one from each side of bow, carried to the breakwater and shackled to the rings in the breakwater, and made amply secure aboard the vessel.

One bow anchor shall have 60 fathoms of anchor chain connected to same, hung in the hawse pipe and connected to the windlass, ready for instant use.

One bow anchor shall be carried aft, connected to 30 fathoms of anchor chain and dropped

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150 feet from the stern of the vessel, and the chain made amply secure to the stern of the vessel.

Note. When anchor chains are found to be in shots of 45 fathoms, the 45 fathoms may be used in place of the above stipulations.

In the event that more vessels wish to moor than the rings in the breakwater will accommodate, such vessels shall moor head to the breakwater, with both anchors down forward with 30 fathoms of anchor chain out on each anchor, and an anchor same size as bow anchors placed astern, with 30 fathoms of anchor chain out, securely fastened to the stern of the vessel.

All vessels must have at least one licensed officer aboard at all times.

The above conditions shall be carried out under the supervision of the Underwriters' representative, Captain Drake of Buffalo, who shall direct the mooring and location of the vessels, and any further fastening shall be supplied by the owner if in the judgment of the Underwriters' representative same is necessary, in which case his decision shall be final. If it is found necessary to move any vessel after mooring, written notice shall be given the Underwriters' representative at least 24 hours before the vessel is moved, and the mooring and re-mooring shall be done under his direction.

In consideration of the above stipulations being complied with to the satisfaction of the Underwriters' representative, and his certificate of approval secured and payment of fee for same made, the vessel or vessels shall be held covered under the policies without additional premium.

NEW YORK STATE CANAL SYSTEM. In general terms, the canal system of New York may be said to consist of the Erie Canal, the Cayuga and Seneca Canal, the Oswego Canal, and the Champlain Canal, together with their several lateral branches and feeders. Extensive operations are now in progress to improve or supersede the present limited canals by enlarged waterways, under a comprehensive plan designated the Barge Canal improvement. Below are given pertinent particulars of the old canals now in use and of the projected Barge Canal.

The Erie Canal is a free waterway having a capacity at present for boats 98 feet long, 17 feet 10 inches beam, and 6 feet draft, with clear headroom under bridges of 12 feet at ordinary water level. This canal connects at the west with Lake Erie at Buffalo and with the Niagara River at Black Rock and Tonawanda, and at the east with the Hudson River at Albany and Troy, and thence with the seaboard at New York. The old Hamburg Canal and the Clark and Skinner Canal, sections of the Erie Canal extending partly through the city of Buffalo, have been abandoned and filled up.

The Cayuga and Seneca Canal connects with the Erie Canal at Montezuma, extending thence to the south and joining Cayuga Lake and Seneca Lakes to the canal system. These are two of the so-called Finger Lakes of central New York, and are from 35 to 40 miles in length each.

The Oswego Canal unites with the present Erie Canal at Syracuse, and affords to boats of the dimensions above stated, an outlet to Lake Ontario at Oswego.

Near the foot of Onondaga Lake, a branch of this canal extends west to Baldwinsville, being a canalization of the Seneca River and known as the Seneca River towing-path; it terminates in an independent canal called the Baldwinsville Canal, which is about ¾ mile long. Boats 98 feet long, 17½ feet wide, and drawing 3½ feet may be accommodated.

The Oneida River improvement, another branch extending to the east from Three Rivers Point, utilizes the Oneida River and reaches Oneida Lake. This canalization is 60 feet wide at the bottom and has a depth of 4½ feet; the locks are 120 feet long and 30½ feet wide. This river is part of the Erie branch of the new Barge Canal, and work on this portion of the new channel is well advanced.

The Black River Canal extends from Rome on the Erie Canal northward to Lyons Falls, and accommodates boats 75 feet by 12 feet, with 3½ feet draft. Beyond this the Black River is nominally a part of the canal system as far as Carthage, being known as the Black River improvement; but in fact, the locks at Lyons Falls are dilapidated and the river improvement is not accessible from the rest of the system.

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